Programming Review

EML3041: Computational Methods

Main concepts

- Sequential programming
- Conditions (if-end; if-else-end)
- Loops (for-end; while-end)
- Functions

Some common MATLAB functions

Find cos of 60 degrees

```
Val=cos(60*pi/180),   Val=cosd(60)
```

Find ln(5)

```
Val=log(5)
```

Find $e^{1.3}$

```
Val=exp(1.3)
```

Go ahead and try $\sin(90^\circ)$, $\sin^{-1}(0.5)$

Answer: 1, 0.5236

Caution

The MATLAB snippets given here may need editing for strings to run in MATLAB.

For example, the single quotes ‘ and ’ have to be replaced with a straighter single quote '

Some important MATLAB statements

disp

```
disp('My name is Slim Shady')
```

fprintf

```
a=12.4; b=12
fprintf('\n Value of a=%g and b=%g',a,b)
% Search help for %g, %e, %f, %s
```

two lines statement

```
syms x
func=x^2-3*x+ ...
    4
```

comment

```
% Project One – EML3041
```

sections

```
%% Problem One
```

help

```
% do this in command window
help syms
```

Plotting

Plot $y = x^2$ from $x = 2$ to $x = 15$

```
x=2: 0.02: 15
y=x.^2
plot(x,y, 'bo','LineWidth',2)
xlabel('x')
ylabel('y')
title ('x^2 graph')
legend('y=x^2')
grid on
```

Some common mistakes

- Using single letter names for variables
- Filenames such as program 2.m or just 2.m or cos.m
- Using " ; " while first writing the program
- Using reserved words, e.g. "length" for a variable
- Not commenting the program
- Not breaking a problem into smaller parts
- Not following the format of given sample project
- Not writing separate programs to learn single tasks

Differentiate a function

Find $\frac{d}{dx}(\sin(2x))$ at $x = 2.3$

```
syms x
Func=sin(2*x)
Df=diff(Func,x,1)
Df2pt3=subs(Df,x,2.3)
Df2pt3=vpa(Df2pt3,12)
```

Find $\frac{d^2}{dx^2}(\ln(x^2))$ at $x = 2.5$

Answer: -0.32

Solve a nonlinear equation

Solve $3 \times 10^{-3} x^2 - 4x = 6$

```
syms x
Func=3E-3*x^2-4*x==6
% See use of both
Soln=solve(Func,x)
% can use
% Soln=vpasolve(Func,x,[-5,6])
```

Solve $x^2 - x = 6$; Choose positive root only

Answer: 3

Simultaneous linear equations

Solve $\begin{bmatrix} 2 & 3 \\ 4 & 7 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -1 \\ -3 \end{bmatrix}$

```
A=[2  3; 4  7]
C=[-1; -3]
% Can use C=[-1 -3]'
Soln=A\C
% Can also use Soln=linsolve(A,C)
% Can also use Soln=inv(A)*C
```

Solve $2x + 3y = 12; 3x + 2y = 60$

Answer: 31.2, -16.8

Interpolation

Interpolate (2,4), (4,16), (5,25) to a 2nd order polynomial

```
X=[2  4   5]
Y=[4   16   25]
n=length(X)
Coef=polyfit(X,Y,n-1)
syms x
Poly=Coef(1)*x^2+Coef(2)*x+Coef(3)
```

Interpolate (2,4), (4,16), (5,25), (8,23) to a 3rd order polynomial.

-0.5694*x^3+7.2639*x^2 -21.6389*x+ 22.7778

Extra: Use a loop to generate the polynomial

Regression

Regress (2,4), (4,16), (5,25) to a 1st order polynomial

```
X=[2  4   5]
Y=[4   16   25]
Coef=polyfit(X,Y,1)
syms x
Poly=Coef(1)*x+Coef(2)
```

Regress (2,4), (4,16), (5,25), (8,23) to a 1st order polynomial.

Answer: 3.0933*x + 2.3067

Solve an integral

Integrate $\int_5^{13} 9x^3\,dx$

```
syms x
func=9*x^3
val=int(func,x,5,13)
val=vpa(val)
%use vpaintegral(func,x,5,13)
```

Integrate $\int_5^{3.2} 4\ln(7x)\,dx$

Answer: -24.111

Solve ordinary differential equations

Solve $4\frac{dy}{dx} + 7y = 5e^{-2x}, y(0) = 12.$ Find $y(13)$

```
syms y(x) x
eqn=4*diff(y,x,1)+7*y==5*exp(-
2*x)
cond=[y(0)==12]
soln=dsolve(eqn,cond)
y13=subs(soln,x,13)
y13=vpa(y13)
```

Solve $6\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 7y = 5e^{-2x},$

$y(0) = 12, \frac{dy}{dx}(0) = 15.$ Find $y(21)$

Answer:-0.00288938

Find the sum of a series (example of loop)

Find $\sum_{i=2}^{7}(3i+2)$

```
sums=0
for i=2:1:7
      sums=sums+(3*i+2)
end
```

Find the sum of a series (example of break)

Find $\sum_{i=2}^{n}(3i+2)$

only till the sum of the series becomes more than 20 the first time

```
sums=0
for i=2:1:7
      sums=sums+(3*i+2)
      if sums>20
            break;
        end
end
i
```

Find the sum of a series (example of continue)

Find $\sum_{i=2}^{11}(3i+2)$ without including $i = 5$ term

```
sums=0
for i=2:1:7
    if i==5
        continue;
    end
sums=sums+(3*i+2)
end
```

Redo problem using if statement instead of continue

Redo problem using while–end statement

Answer: 76

BMI problem (example of if-end)

Find the BMI of a person and find if they are healthy

```
Weight=190; Height=69;
BMI=Weight/Height^2*703
if BMI>25 | BMI<19
    disp('Unhealthy Weight')
else
    disp('Healthy Weight')
end
```

Redo problem where you display underweight for BMI<19; healthy for $19 \leq BMI \leq 25$; overweight for $25 < BMI \leq 30$; obese for $BMI > 30$.

Answer: Overweight

Resources

- How do I do that in the MATLAB series? This series is highly helpful when you are doing the projects for the course: https://autarkaw.org/2020/12/22/how-do-i-do-that-in-matlab-for-usf-students/
- Class lectures in EML3035 when I used to teach the programming course as a 1-credit hour course: http://www.eng.usf.edu/~kaw/class/EML3035/lectures.htm
- Here are some lecture videos freely available from Vanderbilt University: https://autarkaw.org/2020/05/08/need-help-with-programming-in-matlab/
- For help on commands, either enter help in command window or go to https://www.mathworks.com/help/matlab/index.html